Masumi MASHIMA*: A few morphological considerations on etiolated seedlings

真島真澄*: 黄化芽生の形態に関する二三の考察

The morphological features of the etiolated seedling of the dicotyledonous plants are the exaggerated elongation of the internode of the stem and the contraction of the leaf or the stunted growth of the leaf. The exaggerated elongation of the internode of the stem means the exaggerated elongation of the cells which make up the internode of the stem, the increasing division of the cells, or the combination of both. Here I wish to make clear the triple relations of these phenomena, that is the exaggerated elongation of the internode of the stem, the exaggerated growth of the cells and the division of the cells. On the other hand, the leaves of the etiolated seeding generally remain in their embryonic state of growth though we see differences in the degree of growth according to the nature of species. This led me to examine the state of growth in darkness, that of lamina, petiole and stipule, these three parts which make up a leaf, and I have noticed several patterns in the growth of the etiolated leaves.

The material used for experiment are the plants of Leguminosae. In the study of the internode 15 genera, 15 species, 25 varieties were used, while in case of leaves 17 genera, 17 species, 10 varities were the object of my research. I tried to germinate these seeds in a dark chamber, and proceeded to examine their etiolated seedlings in each case, if there were perfect special features of its own. I also tried to eamine the seedings in a normal condition, using by way of contrust the similar material in same days old with the one which had used as my experimental material.

On the exaggerated elongation of the internode

Mac Dougal (103) has made an anatomical study of the features of etiolation using as material the plants of more than 100 species including *Agave americana* with the result that exaggerated elongation of the internode is due both to the exaggerated elongation of cells and the increasing cell division. G. Kraus (1864) is also of the same opinion as the result of the experiments made upon the material of twelve species including *Nicotiana tabacum*. But Sachs (1892) with *Tropaeolum majus*

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and other 5 species; Möbius (1895) with *Ceratophylum* sp. and other few water plants; Fukuda & others (1952) with *Hydrilla verticillata* have proved that the exaggerated elongation of the internode is caused only by the elongation of the cells and not by the cell division. But such a difference of opinion, it seems to me, is due to that of the experimental material. In my case I have taken up leguminous seedling as my experimental material, by which I have found out variety of modes in the way of combining elongation and division of cells in the experiment. I have given due consideration to the length of epidermal cells and proportion of cell division as compared to those normal seedling in each individual and in each internode.

For instance in case of the epidermis of hypocotyl the cell is 10.54 times longer than the normal, while the rate of cell division is 1.14 times greater, and the exaggerated elongation of hypocotyl is observed to have been on caused only by the elongation of cells. In case of two varieties of *Pisum sativum*, early giant and Alasca, the length of the cells of the second internode is 3.04, 4.45 longer than that of the normal one, while the ratio of the cell division is 3.60, 4.91 times longer than the normal one, and the elongation of cells and division have been on the increase resulting in the exaggerated elongation of the internode. In case of *Glycine soja* I have taken up three varieties. In this experiment I have observed the length of hypocotyl and that of the cells is respectively 6.42, 5.01, 4.68 times longer than that of the normal seedling while the ratio of the division of cells is each 0.64, 0.86, 0.81 times longer than the normal seedling. In this case, however, there was no development of the cells, as compared with that of normal seedling.

Even in the same material we observe the great difference in the formulae of combination of elongation and division according to the order of the internodes. For instance, take *Vicia faba* and compare its first, second, third, and fourth internode with those of normal seedling. They are 17.53, 17.53, 13.91, and 5.00 times longer than the normal ones, while the length of the cells are respectively 10.43, 4.39, 1.65 and 0.55 times as much as the normal ones, by which we notice that in case of cells the length is smaller according as the internode goes up, while the rate of division is respectively 16.85, 3.98, 8.69 and 9.09. This table shows that within the first and second internode, the exaggerated elongation within the internode takes place by the exaggerated elongation of the cells and the divisional increase, but with the 3rd and 4th internode the exaggerated elongation takes

place by the increase of the division of the cells.

The exaggerated elongation of the internode in case of the etiolated seedling of the legminous plants observed from the elongation and division of the cells may be reduced to the following formula (refer to Mashima 1957).

(1) the case when caused by both elongation of cells and increasing of their division.

a. elongation rate $>$ division rate

Lupinus perennis (hypocotyl), *Mimosa pudica* (〃), *Phaseolus vulgaris* (1st internode), *Canavalia ensiformis* (〃), *Vigna sinensis* (〃), *Pisum sativum* *Lathyrus odoratus* (〃), *Vicia sativa* (〃)

b. elongotion rate $<$ division rate

Canavalia entiformis (hypocotyl), *Vigna sinensis* (〃), *Pisum sativum* (2nd, 3rd internode)

c. elongation rate$\fallingdotseq$division rate

Phaseolus radiatus var. (1st internode).

(2) the case when caused by elongation of cells only.

a. division rate$\fallingdotseq$1

Astragalus sinicus (hypocotyl), *Dolichos lablab* (1st internode), *Glycine soja* (〃)

b. division rate $<$ 1

Lupinus perennis (1st internode). *Vicia sativa* (2nd internode)

(3) the case when caused by increasing of cells only.

a. elongation rate$\fallingdotseq$1

Cassia torosa (hypocotyl)

b. elongation rate $<$ 1

Vicia fava forma *ascendens* (4th internode), *Pisum sativum*-Giant white (5th internode).

On the formula in the growth of leaves

Various differences may be observed in the degree of growth of leaves of the etiolated plants according to the varieties of the plant. Mac Dougal (1903) explains the various aspects of the growth of the etiolated plants as follows: "..... the reacting any leaf to darkness seems to depend upon structural causes to some extent, and is not conformable to any phylogenetic features of the species involved." J.H. Priestly (1925) observing the remarkable growth of the leaves of *Phaseolus multiflorus* as compared with the leaves of *Vicia faba* and of *Pisum sativum*

suspects that this is due to the endodermis reacting upon the stalks. T. Araki and Hamada (1939) put their explanation to the influence of light intensity upon the upper, middle, and lower parts of the coleoptyl of *Avena sativa*, in which the ratio of the growth and inhibition differs. In my case, I have taken up how the primary leaf (most epigenous) and the first complete leaf (most hypogeous) react upon the dark, in which how the three parts of the leaf, lamina, petiole, and stipule grow, in what degree each of them grow and in what relation they are each other as compared with that of nominal germination were studied, the result of which is as follows.

Various degrees of growth are noticeable in each case of leaf, leaflet, and stipule in contrast to those of normal growth, as these figures show, they are generally smaller than those of the normal ones. In the case of a petiole its growth is different according to the nature of the plant, that is: in constrast to the normal growth some are shorter, others are almost equal and some others are exceedingly of the exaggerated elongation. For instance, the experiments upon 3 varieties of *Phaseolus vulgaris* show that the length of the petiole is respectively 0.59, 0.45, and 0.42 times as much as those of the contrast while in case of *Vigna sinensis* and *Vicia faba* the length of the petiole is respectively 0.93 and 0.94 times as much as those of the contrast, and in case of *Arachis hypogaea*, *Lupinus luteus*, and *Phaseolus viridissimus* their length is respectively 1.87, 2.01 and 2.46 times as much as those of the contrast, a remarkably exaggerated elongation. In this case the length of the epidermal cell is respectively 3.02, 3.64 and 12.91 times as much as those of the contrast while the cell division is not noticeable. Following are the types of the etiolated leaves of the elongation of the legminousal plants specified according to the elongation of the petiole (refer to Mashima 1958).

(1) the case when both of petiole and lamina are shortened.
Phaseolus vulgaris (Shakugosun), *P. vulgaris* (Otebo), *P. vulgaris* (Uzura) *P. radiatus*, *Pisum sativum*, *Robinia pesudoacacia*, *Lupinus perenis*

(2) the case when the length of petiole is ame but only the lamina is shortened.
Vicia faba, *Vigna sinensis*, *Glycine soja* (Shiromame)

(3) the case when petiole elongate exaggeratedly but lamina is shortened.
Phaseolus viridissimus, *Glycine soja* (Kuromame), *Arachis hypogaea*, *Lupinus luteus*.

(4) the case when leaf is hardly developed and remains in embryonic condition.

Astragalus sinicus, Fueraria hirsuta, Robinia hispida, Trifolium repens, Vicia sativa.

Literatures

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摘　　要

双子葉植物における芽生の黄化形態すなわち節間の過伸と葉の縮少に関して，マメ科植物を材料として若干の考察を試みた。

節間の過伸について：節間の過伸がそれらの細胞の伸長と分裂のいかなる組合せの結果をひき起こされるものであるかを個体，節間別に調査したところ，次の場合が見られる。

a. 細胞の過伸と分裂の増加によるもの：ハウチワマメ(胚軸)，ナタマメ(同)，オジギソウ(第1節間)，インゲン(同)，その他多くの胚軸および節間。

b. 細胞の過伸のみによるもの(分裂の増加は伴わない)：レゲソウ(胚軸)，ダイズ(同)，フジマメ(第1節間)，ヤハズエンドウ(第2節間) 等。

c. 細胞の分裂の増加のみによるもの(細胞の過伸は伴わない)：ハブソウ(胚軸)，ソラマメ(第4・5節間)，エンドウ(同)。

黄化葉の生長型について：葉片あるいは小葉片，托葉の大きさは総じて縮小するのであるが葉柄の長さには短縮するもの，ほとんど変化のないもの，過伸するものとが見

え出されたので，葉柄の長さを基準にして，黄化豆芽生の葉の生長を見ると次の型に区別することができる。

a. 葉柄と葉片または小葉片がともに縮小するもの：インゲン，アズキ，エンドウ等。

b. 葉柄の長さは変化はないが，葉片または小葉片は縮小するもの：ソラマメ，ササゲ，ダイズ(白豆)。

c. 葉柄は過伸するが，葉片または小葉片は縮小するもの：ナンキンマメ．キバナハウチワマメ，ダイズ(黒豆)，*Phaseolus viridissimus*.

d. 葉はほとんど発育せず，胚的状態にとどまるもの：レンゲソウ，クズ，*Robinia hispida*，シロツメクサ等。

○ Bells of Ireland とはなんでしょう（久内清孝） Kiyotaka HISAUCHI: What is Bells of Ireland?

米国ミシガン州デトロイト市の Lohrman Co. 発売の Bells of Ireland というものの種子が手に入ったがそれがなんであるかさっぱり見当がつかないので，とにかくまいて見たらシソ科に属する *Moluccella laevis* L. という地中海岸を原産地とするもので，すでに 石井勇義氏の園芸大辞典第1巻 (1944) にカイガラサルヒア Molucca-balm, Shell flower の名で図が出ているし，石井，穂阪共著原色園芸植物図譜第5巻 (1958) には更にカイガラソウの名を追加してあり，両者ともほとんど同じような内容の記事をかかげ昭和初年頃千葉大学園芸学部で初めて栽培したとかいてあるが Bells of Ireland という名は見当らないのみならず，Bailay の百科辞典にもなく，そうしていつどこでだれがつけた名か知ることができない。しかし欧米ではかなり古くから shell flower の名でしられている。とにかく奇ばつなもので，緑色コップ形の合弁萼が横に向き，そのなかに白色の唇形花冠が発達し花は細長く，2裂した下唇弁が萼内をかざる。花後萼は乾燥してコップ形を保つので，そのまま，または着色して乾燥花の材料になるという。

Seeds distributed by Messrs. Lohrman Co., Detroit by the name of Bells of Ireland is *Moluccella lavis* L. The origin or bibliography of this name remains unknown.